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Some Simple Thoughts on Model Building for Developing Countries

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The revival of interest in using models for developing countries for planning and policy advice makes it desirable to draw lessons from past experience. Simple models, focussed on specific issues, are to be preferred to large and comprehensive models. More empirical research is needed on supply and production functions for developing countries. Not statistical criteria but developmental considerations must determine the conclusions to be drawn from models. More explicit explanations of assumptions and modesty in presenting results of modelling work to policy makers are desirable.

1. INTRODUCTION

Mathematical models of economies of developing countries attracted great attention in the 1960s as tools for planning, projections and policy formulation, but received less attention in the following decade.

This diminished appreciation of model building for developing countries, both within and outside the United Nations system, was caused by various factors. First, the expectations of what planning and policy models can achieve, in the view of both policy-makers and model-builders themselves, very often had been set too high and have consequently led to disappointments; secondly, the quality of the models used left much to be desired, very often necessarily so in view of the weak statistical data base and the lack of an appropriate and generally accepted theory of development; thirdly, the international economic developments during the first half of the 1970s brought a new interest in institutional global problems of a more qualitative nature, the issues related to the new international economic order; and, finally, at the national level for developing countries, the interest of planners and development economists shifted from macro-economic growth policies to employment, income

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distribution and other so-called social aspects of development, which for some time were considered to be less amenable to national model building.[1]

Opposite to these negative trends, two other important developments during the 1970s have stimulated the interest for model building. The first is the surge of interest in constructing long-term global models, i.e. models for the world economy, which followed the publication of the so-called Meadows Report, the first report for the Club of Rome in 1973 [6]. The global input-output model, or the so-called Leontief Report [5], for the United Nations is only one of the several global long-term models which have been developed both inside and outside the United Nations system since then.[2]

A second positive factor has been the development of larger, faster and cheaper computers which has greatly facilitated the construction and use of large and complex models. There is also a negative side to this development, namely that computers sometimes substitute for economic thinking.

Recent developments indicate a revival in the interest for model building for developing countries as is evidenced by several new publications and new research activities in this field, also by the regional commissions of the United Nations.[3] This renewed interest provides the opportunity to profit from the experience of the last two decades in building and using models. Against the background of this experience, I shall submit in this article some simple thoughts on model building for developing countries. By "simple" is meant non-technical, because in order not to repeat our mistakes we must draw the lessons from the past, and our mistakes have not been in technicalities but in forgetting often the basic principles of model building.

One warning must be given in advance. As in so many fields of economics, there exists no general agreement about the principles and methodologies for model building among its practitioners. Model building is not just a technique which can be standardized; it is an art, and as in the artistic field, you have different schools with different approaches. In a recent and unusual book that appraises the state of the art

[1]This now has changed. Several studies have included distributional aspects of the development process in national models. See, for example, I. Adelman and S. Robinson [1], Lance Taylor *et al.* [10], and M. Hopkins and R. Van der Hoeven [4] of the International Labour Office, Geneva.

[2]For example, models prepared for the Club of Rome [6;8], global models of various United Nations agencies (World Bank, UNCTAD, UNIDO, UN-secretariat), and models developed by academic research teams. Surveys of several of these models are given in the *Journal of Policy Modeling*. The activities of the International Institute for Applied Systems Analysis (IIASA) should also be mentioned.

[3]For example, recent books by Charles R. Blitzer *et al.* [2], Kemal Dervis *et al.* [3] and Lance Taylor [9]. The *Journal of Policy Modeling:* A Social Science Forum of World Issues, (Elsevier-North Holland, New York) established in 1979, is exclusively devoted to publishing results of policy-modelling research.

of social system modelling [7], one finds, among other things, the responses to a questionnaire sent to all those practically involved in global modelling on a number of specific questions about "how to model". It is instructive and sometimes surprising to see how large a divergence of opinion exists on many basic questions. So, my simple thoughts will not necessarily find universal acceptance; they are biased by my experiences, preferences and, above all, my professional education.

The following is divided in 4 parts. The first part contains some remarks on model building in general; the second part deals with model building for developing countries; the third part discusses multi-country models; and the fourth part highlights uses and abuses of models. On each of these topics only some scattered remarks in a highly selective manner will be made. By models are meant quantitative models for national economies.

2. MODEL BUILDING IN GENERAL

Models are quantified theories about the functioning of reality or about the reality as one would like to see it functioning. Models are simplifications of the real world which is too complex to be described in all details. The simplifications made in models depend on one's perception of how the real world functions. A neutral and objective description of reality does not exist. The description depends on the questions one asks about the reality and the theories one holds about its functioning. Thus, there are two stages preceding the construction of a mathematical model: first, defining of the problem, and second, the formulation of a theory in qualitative terms.

Models are tools for solving problems and, therefore, one should first *define the problem or problems* one wishes to investigate. The nature of the problem is an important determinant of the structure of the model and the role of its variables. It makes a difference whether the problem is one of the short-term (year to year), or of medium-term (4–6 years) or of long-term (more than 10 years) development. What can be assumed as given or constant in the short run, such as population size or technical knowledge, usually cannot be considered constant and given in the long run. And the other way round, utilization of capacity might in the long run be considered given and constant, but in the short run it will fluctuate and must be explained. It makes a difference for the model to be built whether one is interested in changes in the production structure, or in financial and monetary flows, whether the problem is one of positive economics, i.e. of analysis and explanation, or of normative economics, i.e. of policy making. These questions are relevant for the design and use of your models.

The *formulation of the theory in qualitative terms* crucially depends on one's perception of what are the mechanisms, the relations relevant for the analysis of your problem. At this stage, the theory should not already be simplified because of

difficulties expected in measuring or modelling the phenomena considered to be important. If, for example, expectations or social and political factors play a crucial role, these factors should not be eliminated from the hypotheses before one comes to the quantification of the theory. It belongs to the task of the model builder to find approximations of variables which cannot be measured directly or for which no statistics exist.

Theories, like models, are simplifications of reality. How far to go in simplifying reality is a matter of taste. This choice determines whether to use large models or small models. It might be interesting to quote two opposite views on this question resulting from the questionnaire mentioned before:[4]

"Should models be large or small?

– Big models get out of hand. They cannot be explained or documented. They cost a fortune to run. They require data that cannot be found. They are black boxes full of undetectable errors. One should make small, transparent models and complicate them with the greatest reluctance.

– Small models simply do not capture the real world. They are not credible to policy makers who know how complicated the world really is. The bigger the model the more comprehensive and reliable it is."

My preference is for smaller models which bring out the essential features of your theory. They make you understand better what the core processes are and make it easier to explain to policy makers the assumptions of the model. To use a phrase by one of my former non-econometric teachers: using models is like travelling by night train; you know where you get on the train and where you leave it, but where you have travelled in between remains in the dark. This is all the more true for large models.

I have already started to discuss the third stage of model building, namely the *translation of the theory to equations,* the model construction. Here mathematical models show their great potential compared to verbal theories in handling a set of simultaneous relations among various variables. Mathematical models provide simple tests to check consistency, completeness and determinateness of theories which verbal reasoning usually cannot provide. In constructing economic models, one should watch out for the influence of non-economic specialists, mathematicians, system analysts, statisticians and others, who sometimes tend to distort economic theories for the sake of applying their favourite special technique – game theory, Markov-chains, simulations – to conditions where the application of such techniques is inappropriate. Also economists need a warning: input-output models can be a useful tool of analysis, but not for economies where the inter-industrial relations hardly exist, a point of special relevance for models for developing countries.

[4] Quoted from [7] in *Options,* International Institute for Applied Systems Analysis, Spring 1982. p. 15.

Finally, some remarks about the next stage of economic modelling work: the *empirical testing of models.* Econometrics textbooks provide sophisticated standard procedures, tests and measures. Where relevant and possible, these tests should be carried out and their results reported properly. But also here one should keep one's sense of realism and avoid mechanistic and purely statistical approaches. Whether hypotheses in models should be refuted or not does not just depend on the results of applying statistical tests. Economics should have the last word: variables with wrong signs, numerical values for regression, regression coefficients and elasticities which are abnormally high or low should not be accepted without further analysis even if the statistical reliability of such estimates seems high. Statistically significant but low (R^2)s should not be the basis for accepting the tested theories. In evaluating theories, all relevant empirical information should be used, whether of an econometric nature or not.

3. MODEL BUILDING FOR DEVELOPING COUNTRIES

The usefulness of national models is not the same for all developing countries; neither can one expect the desirable structure of such models to be the same for all of them, for large and small countries, for oil-exporting or oil-importing countries, for semi-industrialized and least developed countries. For small, least developed or island economies, for example, there is probably no great need for a complicated econometric model. A simple system of national accounts and good-procedures for project planning and socio-economic project evaluation would be more important for such countries.

But, accepting the large differences that sometimes exist between individual developing countries, most of them have a number of common features which make model building especially difficult. I mention some of those features.

Supply constraints, not only for physical capital, but also for skills of different types, are the main determinants of economic growth of developing countries. Production functions and supply equations thus become more important in models for developing countries than in those for industrialized countries, in which demand factors have a dominant influence.

Many developing countries do not have a fully integrated national economy. Nearly by definition the price mechanism and markets do not function in an efficient way; in particular the labour market is a complex and insufficiently investigated market. The physical and institutional infrastructure (both public and private) is weakly developed. Structural changes can be important where productive sectors start from a zero-level of production. External influences, through trade, investment and prices, determine in many developing countries their domestic development process. Owing to these and many other factors, in several developing countries stable and predictable relations are often lacking, and structural changes and external

disturbances prevail. General theories about how national economies of developing countries are operating do not yet exist. In these conditions, the construction of national econometric models is a difficult task, in particular because the relevant statistical information is often absent or unreliable.

These structural characteristics should make us modest in claiming what national models can do. Some priorities for research follow from this description. A first need is to expand and improve in a systematic way and according to the priorities set by policy makers the statistical data base of the economy. Secondly, more empirical research is needed on certain aspects of the national economy, such as the functioning of the labour market, private investment decisions for the non-agricultural sector, price formation, and the links between the domestic economy and the rest of the world. These partial studies can provide elements for improving the structure of national models. These models in their present form could form the framework for the partial empirical research studies.

For the reasons mentioned, the structure of the models developed for industrial countries cannot be a prototype of models for developing countries. A model will have to capture the essential economic characteristics of the economy, and this will lead to different types of models for different groups of developing countries. The differences will be reflected in:

1. the actors that play a role in the economy, in particular the distinction between actors of domestic and foreign origin.
2. the classification of production sectors. In an economy where agriculture produces 40 percent of the GDP and the manufacturing sector 15 percent, a sub-division of agriculture in several subsectors may be required, while in manufacturing either no disaggregation is required or at best a disaggregation into only 2 subsectors (modern and traditional) will do.
3. a regional sub-division of the economy, at least in urban and rural areas, but sometimes in greater details.
4. the technical and behavioural equations. As mentioned already, no input-output technical equations are needed for economies in which inter-industrial relations are weak. Behavioural equations should refer to the main economic and social actors in the economy, domestic and foreign. For small economies, the links between the domestic economy and the rest of the world will have to be specified in sufficient and appropriate detail.
5. values of parameters which will signify the differences in economic structure between different economies.

In summary, the main principle to be followed in constructing models for developing countries is to assess clearly the main characteristics of its functioning and the rest will follow, although not very easily.

4. MULTI-COUNTRY MODELS

Models which link the models of several economies or groups of economies are called multi-country models; more generally, interlinked country model systems. They have been formulated for groups of industrialized countries by the Organisation for Economic Co-operation and Development (OECD) and the European Economic Community (EEC). Well known is also the LINK-system developed by Professor Lawrence Klein of Pennsylvania University. Here our interest is in multi-country models for groups of developing countries.

Multi-country models are useful for studying the transmission of fluctuations in overall activity or of the effects of structural changes from one country to another. They are also helpful in studying the potential for trade co-operation and economic co-operation among groups of countries generally. Multi-country models can cover in a comprehensive way all economic relations, but also more selectively certain relations, as is for example the case in multi-country models for industrial co-operation, developed for the ASEAN countries [11].

Most models for open economies are based on the "small country assumption", i.e. exports and imports are assumed not to influence world market prices and/or income in the rest of the world. This might be realistic for a small country acting in isolation. However, for several small countries acting simultaneously, the assumption might no longer be realistic. Multi-country models can also cope with this situation.

The importance of multi-country models depends very much on the strength of the economic links, both actual and planned, among countries. Economic links between countries exist through trade of commodities, flows of factor and non-factor services, and real, financial and monetary flows. Not only volumes but also prices of goods and services, interest rates and exchange rates enter into these relations.

One of the main tasks of multi-country models is to study the determinants of inter-country relations. It is an empirical matter to decide which countries should be included in a multi-country model. When the economic links, not only through trade but also through other channels, are weak or work only in one direction, there is less need to include such countries in a multi-country system. Another reason for limiting the number of countries in the model is that the complexity of the model increases rapidly with larger number of countries.

The question which countries to include in a multi-country system should be explicitly studied in view of the objective of developing such a system. Special attention must also be paid to the classification of countries or regions in the "rest of the world", the countries outside the interlinked system of national models. The links with countries or regions in the rest of the world can be more important than those with countries within the system. For many developing countries the links

with the industrial countries (the United States or the countries of the European Community, for example) are more important than those with neighbouring countries in their region. This requires an appropriate disaggregation of the "rest of the world" into a few relevant groups and a detailed specification of the relations with these groups.

Another point to be considered is that national models of the interlinked system must be constructed in such a manner that they can generate adequately the transmission mechanism which links the national economies. This does not require that all national models should be uniform in structure, but they must have a number of common features which are determined by the problems one wishes to study through the system. The domestic structure should not be modelled in greater detail than is necessary for generating the appropriate inter-country links.

5. USES AND ABUSES OF MODELS

The main uses of models are for analysis or explanation, and for planning or policy making, and often the first has to precede the second use.

Models for policy making can be of different types: fixed-target or optimization models, simulation models, forecasting or projection models. Whatever model is used, no policy conclusions should be derived until one has fully understood in economic terms the outcomes of the models and until one has obtained the maximum output from them. No policy conclusions should be drawn from the models unless we are sufficiently confident that our models permit such conclusions. Economists should here have the last word.

The results of the modelling work must be presented technically in a systematic and complete way, showing the basic data used, their sources, the estimation, and the results of experiments. But model builders must also present their results to policy makers and the general public in understandable and non-technical language. They must present not only forecasts or projections, but also the assumptions on which these results are based.

Model builders have a great responsibility when they derive policy advice from their models. They should only do so when their modelling work really justifies such conclusions. They should have the courage to keep their computer printouts for themselves when required, or present their conclusions in qualitative terms (positive or negative effects, large or small) or in ranges of numbers, rather than in numbers of 6 decimals because the computer produces them so easily. To suggest a precision which is an illusion easily leads to an abuse of the modelling work.

Models should be considered tools of analysis or tools to assist in policy making. They can help to clarify our thinking on specific problems, to critically examine prevailing views or disputes between different policy advisers. They never can and will be the only instruments for policy making, because our models are too

simple to take account of all relevant factors or to forecast in a reliable way, in particular in the conditions of many developing countries.

The recommendations made in this article are a tall order for model builders and in practice it can be very difficult to follow up much of the advice. However, it is worth making the effort, because models can make a crucial contribution to the understanding of economies and to the formulation of policies. The true test of the value of models should not be a comparison between the forecasts or projections they produce and the realizations, but the comparison of the models with other methods in terms of the extent of gap produced between forecasts and realizations. I doubt very much whether such a comparison would show better results for other methods, because quantitative models are no worse than the verbal theories on which they are based. In fact, mathematical models are better because of their quantification of theories. This should not give reason for being satisfied, but it must be a stimulus for further improving the quality of our models.

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